Profiles of Physical Function, Physical Activity, and Sedentary Behavior and their Associations with Mental Health in Residents of Assisted Living Facilities

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Abstract

Background. The current study used latent profile analyses to identify classes of older participants based on physical health, physical function, light physical activity, moderate-to-vigorous physical activity, and sedentary behavior, and then examined differences in mental health between these classes.

Methods. 85 residents (*M* = 77.5 years old, *SD* = 8.2) from assisted living facilities participated. Light physical activity, moderate-to-vigorous physical activity, and sedentary behavior were assessed by accelerometers, physical function was measured using different tasks (mobility, grip strength, and spirometry), and body mass index was calculated. Mental and physical health (i.e., anxiety, depression, fatigue, vitality, and subjective mental and physical health) were assessed by questionnaires.

Results. Latent profile analyses revealed three classes: 'Class 1: Low physical function and physical activity with a highly sedentary lifestyle' (27.1%), 'Class 2: Moderate physical function and physical activity with a moderate sedentary lifestyle' (41.2%), 'Class 3: High physical function and physical activity with an active lifestyle' (31.8%). The results revealed that the latter class reported better mental health than the other two classes.

Conclusions. This study suggests that health promotion for older adults might benefit from identifying profiles of movement-related behaviors when examining the links between physical activity and mental health. Future study should test the intervention potential of this profiling approach.

Keywords: Latent profile analysis, active lifestyle, accelerometer, older adults

Introduction

With an increasingly aging population, it is important to explore factors related to maintaining good physical and mental health in older age. Recent evidence indicates that approximately 15% of older people (≥ 60 years) across the world are diagnosed with a mental health disorder (WHO, 2016). This study examined mental health and some of its movement-related correlates in residents in assisted living facilities. Assisted living facilities offer assistance with daily living activities, but the residents are largely independent (Carder, 2002). Poor mental health is prevalent in older adults residing in these settings and related to transfers to nursing homes (Aud & Rantz, 2005; Watson, Garrett, Sloane, Gruber-Baldini, & Zimmerman, 2003) such transfers have individual and societal costs (Hawes, Rose, & Phillips, 1999).

A physically active lifestyle is central to maintaining mental health in older adults. For example, engagement in objectively-assessed daily moderate-to-vigorous physical activity is related to lower prevalence of depressive symptoms (Vallance et al., 2011). Light physical activity, the most common intensity of physical activity for older adults, can also be important for reaping mental health benefits (Buman et al., 2010; Song, Lee, Baek, & Miller, 2011). Recent evidence also indicates that sedentary behavior is negatively associated with psychological health in adults independently of physical activity. For example, higher levels of sedentary behavior were related to depression or depressive symptoms (Hamer et al 2014, Kang et al 2013, Lucas et al 2011), however this has not been found in other studies (Rosenberg et al 2016).

Older adults living in assisted living facilities are at greater risk of experiencing compromised psychological health (Watson et al., 2003), and have lower levels of light physical activity compared to those living independently (Moran et al., 2015). Given the important roles of physical activity and sedentary behavior in mental health in community dwelling older adults, gaining more knowledge about these associations in people living in assisted living facilities might be informative to improve mental health in this particular population of older adults.

Physical function is another factor related to physical and mental health in older adults. For example, better physical function has been related to less time spent sedentary (Lee et al., 2015) and a smaller risk for re-hospitalization (Soley-Bori et al., 2015). However, the reported associations between physical function and mental health in people living in assisted living facilities are inconsistent. For example, a pilot study of assisted living facility residents revealed no associations between the use of a walking aid and depressive symptoms (Wyrick, Parker, Grabowski, Feuling, & Ng, 2008), but grip strength and repeated chair rise were related to depression in another study (Giuliani et al., 2008). Such inconsistent findings might suggest that when exploring the associations between functional ability and mental health, it is important to incorporate a range of measures of physical function. Given that some of the measures have been reported to be influenced by physical activity, levels of physical activity should also be taken into consideration. Unfortunately, studies that reported on associations between physical function and mental health in residents of assisted living facilities did not report physical activity.

Latent profile analysis was used to identify such profiles. With this method, individuals are classified into distinct classes on the basis of their homogeneity of scores for different behaviors (i.e., light physical activity, moderate-to-vigorous physical activity, physical function, and sedentary behavior; Soley-Bori et al., 2015). Subsequently, differences between the classes of people on dependent variables of interest can be explored. This person-centered model can be distinguished from a variable-centered model (e.g., regressions, ANOVAs) in which the aim is to explore relations between variables, ignoring how these variables are combined within people. A person-centered model is more appropriate when individuals in a sample have heterogeneous characteristics (Muthen & Muthen, 2000). As such, this model is more suitable for use when considering the variable health status of residents in assisted living facilities. Previous studies adopting latent profile analysis revealed that different profiles reflecting mental health and health-related variables were related to self-reported physical activity in middle aged adults (Gerber & Jonsdottir, 2014). To date, latent profile analysis has not been used to explore the associations between physical function, light physical activity, moderate-to-vigorous physical activity, sedentary behavior, and mental health in older adults. The primary aim of this study was, therefore, to examine such associations using latent profile analysis. We hypothesized that a number of distinguishable profiles would be identified based on individuals' physical function, physical health, light physical activity, moderate-to-vigorous physical activity, and sedentary behavior proportions. Further, we expected the individuals in profiles with better physical function, more light physical activity, more moderate-to-vigorous physical activity, and less sedentary behavior would report better mental health than those individuals in profiles with worse physical function and less movement.

Methods

Participants

Participants were recruited from 13 assisted living facilities across England. Assisted living facilities were identified through either online searches or via websites (www.housingcare.org). Following approval from managers of interested facilities, residents were informed of the study through their assisted living facilities newsletter or well-being staff, as well as during coffee morning or monthly meetings. A total of 85 residents (female= 68.2%, male= 31.8%, M_{age}= 77.46, *SD*= 8.17, age range= 65-99 years) took part in the study (see Table 1). Demographic information and disease prevalence are reported in Table 1. Residents who needed a wheelchair or scooter for their daily activities were excluded from the study. The majority of the participants did not use an assistive device for walking (80%); only 9 participants (10.6%) used a stick and 8 participants (9.4%) used a walking frame. The study was approved by the Ethical Review Committee of a UK university. All participants provided informed consent before participating.

Procedures

All assessments were carried out in a dedicated space in the participants' assisted living facilities. All participants completed two testing sessions, which were scheduled one week apart. At the beginning of the first session, research staff explained all procedures to the participants. After this, body composition, spirometry, grip strength, and timed up and go assessments were conducted. These measurements took approximately 40 minutes and were carried out between 9 am and 4 pm. Following these measurements, a questionnaire pack was given to participants, who were asked to complete it during the next week. In addition, participants were given an accelerometer to wear during that week, and were asked to keep an activity diary to record the wear time of the accelerometers.

Measures

Body composition: A portable body composition monitor (TANITA BC-545N) was used to measure weight (kg). Height (m^2) was measured using a stadiometer (Seca Leicester Height Measure). Body mass index (BMI) was calculated using the formula: weight [kg] / height [m^2].

Lung function: *S*pirometry was conducted to measure lung function using a hand-held spirometer (Micro Medical Micro Ms03 spirometer). Participants were seated for at least 5 minutes before the assessment was taken, and remained seated throughout. First, a clip was placed on the nose of the participants to prevent exhaling or inhaling through the nose. All participants conducted this assessment twice with a short break in between the assessments. Forced expiratory volume in 1 second was provided and reported on the screen of the monitor.

Forced expiratory volume in 1 second was recorded as the highest volume of exhaling (American Thoracic Society, 1987). The mean of two forced expiratory volume in 1 second results was taken and was standardised by height^2 (forced expiratory volume in 1 second/ht^2) (Miller, Pedersen, & Dirksen, 2007).

Grip strength test: Grip strength was measured using a digital dynamometer (TAKEI T.K.K. 5401 Grip-D, Japan). Participants were asked to stand up and grip the dynamometer as tight as possible with their dominant hand (Shinkai et al., 2003). The test was conducted twice, with the second test done approximately 10 seconds after the first assessment. The average of the two measurements of grip strength was calculated and expressed in kg.

Mobility test: The Timed Up and Go test was conducted to measure mobility, including the use of assistive device, and balance (Podsiadlo & Richardson, 1991). Participants were asked to get up from their chair, walk 3 meters and return to the chair.-A researcher demonstrated the procedure and participants were given the opportunity to practice. Mobility was measured as the number of seconds taken to complete the task.

Subjective physical and mental health: The SF-12 was used to measure physical health and mental health of the participants (Ware, Kosinski, & Keller, 1996). In this 12-item questionnaire (6 items for each sub scale) participants were asked to respond to statements which asked about their general physical and mental health over the last 4 weeks (e.g., “During the past 4 weeks, how much did pain interfere with your normal activities?”; “During the past 4 weeks, did you have a lot of energy?”). Items were weighted and summed according to existing guidelines (Ware, Kosinski, & Keller, 1998). A higher score of subjective physical health and mental health indicates better physical and mental health respectively.

Subjective vitality: The 5-item subjective vitality scale was selected (Ryan & Frederick, 1997). Items (e.g., “I felt alive and full of vitality”) were rated on a 7-point scale ranging from 1 (*not at all true*) to 7 (*very true*). Participants' responses across the 5 items were averaged to provide an overall score for subjective vitality.

Anxiety and depression: The Hospital Anxiety and Depression Scale (HADS) was used to measure anxiety and depressive symptoms (Zigmond & Snaith, 1983). This questionnaire comprises 7 items to measure anxiety (e.g., "I can sit at ease and feel relaxed") and 7 items for depression (e.g., "I still enjoy the things I used to enjoy"). The items were summed for analysis.

Fatigue: Feelings of "general fatigue", "physical fatigue", "reduced activity", "mental fatigue", "reduced motivation" were assessed using the Multiple Fatigue Index (MFI-20; Smets, Garssen, Bonke, De, & Haes, 1995). A five-point scale was used ranging from (1) *yes, that is true* to (5) *no, that is not true* to answer questions (e.g., "I feel fit"). For the purpose of latent profile analysis, individual subscales were calculated and all subscales were summed to represent the overall degree of fatigue experienced.

Quality of life: Quality of life was measured using the Dartmouth CO-OP Chart (Jenkinson, Mayou, Day, Garratt, & Juszczak, 2002). The scale identifies 9 domains relevant to quality of life (i.e., physical fitness, feelings, daily activities, social activities, pain, change in health, overall health, social support, and quality of life), and a reference is made to the past 4 weeks (e.g., for emotional problems: "During the past 4 weeks, how much have you been bothered by emotional problems such as feeling anxious, depressed, irritable or downhearted and sad?"). A total score was used for the purposes of latent profile analysis.

Physical activity and sedentary behavior: Activity monitors (models: GT3X+, WGT3X-BT; ActiGraph, Pensacola, FL, USA) were used to assess sedentary behavior, light physical activity, and moderate-to-vigorous physical activity. These two accelerometer models have demonstrated high intra-monitor reliability and have been validated with acceptable criteria (Miller, 2015). The monitors were set to collect counts at 60s epochs. An algorithm was adopted to classify non-wear time (consecutive zeros: 90 minutes, tolerance allowance: 2 minutes between 0 and <100 counts; Choi, Ward, Schnelle, & Buchowski, 2012). Participants were instructed to wear their monitor on their right hip and to remove it during sleep and water-based activities (e.g., showering, swimming). Based on the daily start and stop times of wearing accelerometers recorded in a time log by participants, we set a time frame to represent waking hours (7 am – 10:30 pm). Data recorded during this time frame were extracted to determine minutes per day spent sedentary and in different intensities of physical activity. Inclusion criteria for valid accelerometer data were 10 hours of wear time per day, on a minimum of 3 days, including a weekend day. Data from participants meeting these criteria were retained for use in subsequent analyses (N = 101, accelerometer protocol compliance = 89, no questionnaire responses = 4). The final sample, therefore, included N = 85 participants. Classification of the accelerometer data was conducted using criteria by Matthews et al. (2008) for sedentary behavior, and Troiano et al. (2008) for light physical activity and moderate-to-vigorous physical activity: sedentary = 0 to 99 counts per minute (cpm), light physical activity = 100-2019 cpm, moderate physical activity = 2020-5998 cpm, vigorous physical activity = ≥5999 cpm. The sum of moderate physical activity and vigorous physical activity represented moderate-to-vigorous physical activity.

Minutes spent sedentary, in light physical activity, and in moderate-to-vigorous physical activity recorded across all valid days were summed and divided by the number of valid days to determine minutes/day spent in each activity. For the purpose of latent profile analysis, activities were expressed as a percentage of wear time (calculated as minutes spent in each activities (min/day) / average wear-times (min/day) x 100), in order to adjust for inter-participant variability in accelerometer wear time (Booth et al., 2014).

Statistical analysis

IBM SPSS version 22.0 was used to calculate descriptive statistics and estimate bivariate correlations. Missing data (26 items from different questionnaires were missing) were imputed using the expectation maximization (EM) algorithm (Enders, 2001). We ran LPA in Mplus version 7.4 (Muthén & Muthén, 2015) using the robust maximum likelihood (MLR) estimator. All physical function variables (continuous) were standardized into *z*-scores. The BCH method (Asparouhov & Muthén, 2014) was employed for class comparisons using the mental health variables as (continuous) as auxiliary distal outcomes. A nested model comparison approach was used, comparing more complex models (*k*-class model) with simpler models (*k*-1 class model) to determine the number of classes to retain in the final model. We estimated models with one to four latent classes. When deciding on the final latent class solution, we used a number of statistical criteria, such as the Akaike information criterion (AIC), Bayesian information criterion (BIC), the sample-size adjusted BIC (SSA-BIC), Lo-Mendell-Rubin adjusted LRT test (adjusted LMR), bootstrapped likelihood ratio test (BLRT), entropy, and proportion of participants in each class. Lower AIC, BIC, and SSA-BIC values indicate better model fit. Statistically, significant adjusted LMR and BLRT values indicate that the *k*-class model provides a better fit to the data compared to the *k*-1 class model. In addition, higher entropy and the proportion of participants in each class were also considered when comparing the nested models. We took the class size into account because very small class sizes may result in imprecision and low power (Berlin, Williams, & Parra, 2014). These statistical criteria, in combination with substantive meaning, guided the choice of the final model (Marsh, Lüdtke, Trautwein, & Morin, 2009). Finally, we conducted chi-square difference tests using the BCH method to examine differences amongst the classes regarding mental health. Initially, 100 starting values were used with the 20 best retained for the final solution. The final model was also replicated using 500 random start values.

Results

Table 2 displays the descriptive statistics and bivariate correlations between the study variables. The participants spent on average 201.13 min/day (SD= 71.96) in light physical activity, 9.74 min/day (SD= 9.62) in moderate-to-vigorous physical activity, and 511.93 min/day (SD= 105.72) in sedentary behavior. As can be seen from Table 2, light physical activity, moderate-to-vigorous physical activity, subjective physical health, forced expiratory volume in 1 second, and mobility were positively correlated with mental health, whereas sedentary behavior was negatively correlated with mental health. No statistically significant correlations were found between grip strength, BMI, and mental health.

The statistical criteria indicated that the three-class model had a better model fit compared to the two-class model (except for the lower entropy value; Table 3). Some model fit indices indicated a slightly better model fit for a four class model compared to the three-class model. Adding a fourth class, however, did not provide a better understanding of the data and one of the classes in the four-class solution was very small ($n \approx 11$). In line with recommendations by Marsh et al. (2009), we considered the theoretical and substantive meaning of each class and concluded that adding a fourth class did not contribute to a better understanding of the data in the current study. The three latent classes are graphically depicted in Figure 1. The first class (class 1) was labeled 'low physical function and physical activity (including light physical activity and moderate-to-vigorous physical activity) with a highly sedentary lifestyle' and contained 27.1% of the sample. Class 1 was characterized by people who were not very physically active, perceived their physical health as poor, and showed poor physical functioning. The second class (class 2) was referred to as 'moderate physical function and physical activity with a moderate sedentary lifestyle' and consisted of 41.2% of the sample. Class 2 was characterized by moderately active people who reported moderate levels of physical health and showed moderate physical functioning. The third class

(class 3) was labeled ‘high physical function and physical activity with an active lifestyle’ and included 31.8%. Class 3 was characterized by physically active people that reported that their physical health was good and showed a high level of physical functioning. The largest mean differences across all profile indicators were found between class 1 (low physical function and physical activity with a highly sedentary lifestyle) and class 3 (high physical function and physical activity with an active lifestyle).

Table 4 shows the latent profile characteristics of the three-class model. Large effect sizes (Cohen's $d \geq 0.8$; Cohen, 1988) were observed across all profile indicators between class 1 and class 3. In contrast, the effect sizes of the differences between class 2 and class 1 ranged from medium to large, and those between class 3 and class 2 ranged from small to large (small = 0.2, medium = 0.5; Cohen, 1988).

The mental health scores of the three classes are presented in Table 5. The means of subjective mental health and vitality (higher values indicate better mental health) increased from class 1 to class 2 to class 3. The means of quality of life, anxiety, depression, and fatigue (higher values indicate worse mental health) showed an opposite pattern and decreased from class 1 to class 2 to class 3 (Table 5). The overall tests for the class comparisons were statistically significant for all mental health variables, except subjective mental health, indicating an overall difference amongst the three classes. The specific class comparisons showed that people in class 1 reported lower quality of life, less vitality, and higher levels of depression and fatigue, compared to individuals in classes 2 and 3. People in class 1 also reported lower levels of subjective mental health and higher levels of anxiety compared to individuals in class 3. In class 2 people also reported lower quality of life, less vitality, and higher levels of anxiety, depression, and fatigue compared to individuals in class 3. Large effect sizes were found between class 1 and class 3 for vitality (d = 1.24), fatigue (d = -1.89), depression (d = -1.67), anxiety (d = -1.02), and quality of life (d = -1.43).

Given the high correlation between sedentary behavior and light physical activity, an additional latent profile analysis was conducted without light physical activity as one of the factors. These analyses revealed that taking out light physical activity did not significantly influence the number of participants in each class (class 1: 28.2%, class 2: 42.4%, class 3: 29.4%). Importantly, the reported differences between the classes with regard to the mental health outcomes remained similar to the ones presented above.

Discussion

The present study used latent profile analysis to classify individuals, based on their physical health, physical function, physical activity, and sedentary behavior proportions, in one of three distinct classes. All class indicators were standardized and the classes were compared against each other on the basis of whether their mean score on each class indicator was around the mean ($z = 0$) of the whole sample, above the mean (positive z scores) or below (negative z scores) the mean. The first class (27.1% of the sample) included individuals who, compared to the other two classes, had much lower levels of physical activity, higher levels of sedentary behavior, were more overweight, and had poorer functional health. The second class was the largest class (41.2%) and included individuals who had average scores, compared to the other two classes, on all class indicators. The third class (31.8%) included individuals who were substantially more active and less sedentary than the rest of the sample, were somewhat leaner, and had somewhat better physical health and functioning.

The most notable differences between classes 1 and 3 were found in sedentary behavior, light physical activity, moderate-to-vigorous physical activity, mobility, and perceived physical health. The results showed a large effect size (Cohen`s $d \geq 0.8$; Cohen, 1988) in mobility between classes 1 and 3 and 1 and 2. Given that older adults spend a great amount of time engaging in light physical activity (e.g., walking; Ainsworth et al., 2000;

Westerterp, 2008), this suggests that walking might be particularly important in terms of supporting the mental health of older adults in assisted living facilities. It is also worth noting that sedentary behavior and light physical activity were highly correlated, and that the associations between sedentary behavior and light physical activity with mental health and functional measures were the reverse of each other. This suggests that the message for residents of assisted living facilities would be to spend less time in sedentary behavior and more time in light physical activity. Indeed, the importance of replacing sedentary behavior with this ‘nonexercise’ activity (light physical activity) has recently been reported to have a significant effect on mortality risk (Matthews et al., 2015).

However, the classes not only differentiate between health behaviors, there are also notable differences in physical function, with lung function, grip strength, and mobility being substantially poorer in class 1 compared to class 3. From a clinical perspective, this suggests that those with poorer physical function could also be at higher risk to suffer from poorer mental health. Of particular interest is perceived physical health, given that poorer perceived physical health is a strong predictor of all-cause mortality (Phillips, Der, & Carroll, 2010).

The results of the present study also indicated differences between class 1 and class 3 in several mental health indicators. These results are in line with previous studies showing that lower anxiety and depression symptoms (Azevedo Da Silva et al., 2012; Song et al., 2011), lower fatigue (Vallance, Boyle, Courneya, & Lynch, 2014), and higher walking speed (Ní Mhaoláin et al., 2012) were related to higher levels of physical activity.

These results further show that those with greater physical function and a more active and less sedentary lifestyle had better mental health compared to those with poorer functional ability and low PA and highly sedentary lifestyle. This finding emphasises that interventions aimed at improving physical function and encouraging an active lifestyle are likely to have an important impact on mental health. Despite the effect sizes being somewhat smaller, it is also worth noting the differences in mental health between class 1 and class 2. This shows that even those with moderate physical function and physical activity with a moderately sedentary lifestyle have better mental health compared to those with low physical function and physical activity and a highly sedentary lifestyle. This implies that a small change in lifestyle and physical function could lead to improvements in mental health. This is in line with physical activity guidelines which state that even if older adults cannot achieve the recommended level of physical activity, some physical activity engagement is better than no physical activity engagement (Warburton & Bredin, 2016).

The present study incorporated a range of profiles based on movement-related behaviors and functional abilities and examined differences amongst these profiles in mental health outcomes. Importantly, our findings extend previous findings by taking a person-centered approach and examining how physical activity, sedentary behavior, physical function, and health combine into distinct profiles, instead of examining them as independent predictors of mental health. For example, inspecting the effect sizes of the differences between all three classes (Table 4), shows consistently high effect sizes in terms of levels of physical activity, sedentary behavior, and physical health. Differences in functional ability and BMI are also important but smaller in size, depending on which classes are compared. Identifying classes of individuals is important for reaching better conclusions. For example, comparing individuals on the basis of their physical functioning scores, without taking into consideration how active these individuals are, is likely to give a false indication of how their functional ability relates to their mental health.

This study is not without limitations. The cross-sectional study design does not allow for the assessment of temporal patterns or causal relations between the variables in the profiles and the mental health variables. Further, the stability of the class membership over time could not be tested. No information was available regarding the medication taken by the participants, therefore future studies could explore the impact of medication on the outcome measures and class profiles. Another limitation is the small sample size. In the current study we used many and high quality indicators (e.g., objectively-assessed physical activity, sedentary behavior and physical function), two factors that can compensate for small sample sizes, for example, by decreasing mean class proportion bias (Wurpts & Geiser, 2014). Small sample sizes in latent profile analysis with a moderate numbers of classes can explain more variance compared to many classes derived from large sample sizes (Marsh et al., 2009). However, future research with large sample sizes should further examine the profiles and the associations found in the present study. Participants were recruited from different assisted living facilities. As the number of participants from each assisted living facility ranged from 1 to 33 residents, it is not possible to conduct any meaningful comparisons between the residents from the different assisted living facilities. Similarly, the majority of the participants did not use a walking aid, therefore, it was not possible to explore the influence of the use of walking aids on our results. In addition, no data were collected considering the person-centered care activities in each assisted living facility, which could have an impact of some of the outcome measures. Therefore, future research is warranted to explore the impact of these kind of activities on the associations reported in the current study. Notwithstanding these limitations, the study makes several unique contributions to the literature. Strengths of this study include objective assessments of physical function, physical activity, and sedentary behavior in assisted living facility residents. This is particularly relevant given the known underestimation of sedentary behavior and over estimation of physical activity when using self-reported measures (Tudor-Locke & Myers, 2001). Another strength is the inclusion of multiple mental health indices, both negative (e.g., depression) and positive (e.g., vitality). The majority of the studies which assessed the associations between physical activity, sedentary behavior, and functional ability have limited their assessment to only a few measures of mental health (Biswas et al., 2015; Chodzko-Zajko et al., 2009; Turvey, Schultz, Beglinger, & Klein, 2009). The person-focused approach we used provides an alternative view to the traditional variable-centered approach utilized in the literature that examines activity-related correlates of mental health in older adults. Lastly, our research investigates older adults in assisted living facilities, an under-researched group of older adults.

Findings from our study could be utilized to help these individuals remain mobile and mentally healthy, and avoid or prolong move to full care facilities. Our findings can be useful for health promotion research and practice in terms of developing more targeted/profile-based interventions that take into account variations in scores across a range of movement and functional abilities. Further research should develop targeted interventions (focusing on improving physical functioning or levels of physical activity or both) based on individuals' profiles to examine changes in means and proportions of each class, and whether such changes predict changes in mental health outcomes.

Conflict of Interest

There are no conflicts of interest.

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Table 1.

Demographics and Characteristics of Participants

Variable	
Age, *M* (*SD*)	77.46 (±8.17)
Sex, *n* (%)	85
Male	27 (31.8 %)
Female	58 (68.2 %)
Education	
Secondary, *n* (%)	26 (30.6 %)
Higher, *n* (%)	8 (9.4 %)
Post graduate, *n* (%)	1 (1.2 %)
Other, *n* (%)	8 (9.4 %)
None of above, *n* (%)	32 (37.6 %)
Missing	10 (11.8 %)
Age left school, *M* (*SD*)	15.29 (*SD* 1.13)
Missing, n (%)	3 (3.5 %)
Marital status	
Married/co-habitated, *n* (%)	35 (41.2 %)
Widowed, *n* (%)	39 (45.9 %)
Single (never married), *n* (%)	2 (2.4 %)
Separate, *n* (%)	9 (10.6 %)
No. of children, *M* (*SD*)	2.4 (*SD* 1.29)
Missing, *n* (%)	2 (2.4 %)
Alcohol consumption	
Current, *n* (%)	51 (60.0 %)
Previous, *n* (%)	17 (20.0 %)
Never, *n* (%)	15 (17.6 %)
Missing, *n* (%)	2 (2.4 %)
Smoking	
Currently, *n* (%)	4 (4.7 %)
Previously, *n* (%)	43 (50.6 %)
Never, *n* (%)	37 (43.5 %)
Missing, *n* (%)	1 (1.2 %)
Ethnicity	
White British, *n* (%)	81 (95.3 %)
Irish, *n* (%)	2 (2.4 %)
Other white, *n* (%)	1 (1.2 %)
Asian, *n* (%)	1 (1.2 %)
Annual income before retirement or current	
< £20,000, *n* (%)	50 (58.8 %)
£20,000 - £35,000, *n* (%)	18 (21.2 %)
£35,000 - £45,000, *n* (%)	2 (2.4 %)
> £45,000, *n* (%)	2 (2.4 %)
Missing, *n* (%)	13 (15.3 %)

Self-reported disease	
Diabetes, *n* (%)	10 (12.0%)
Cardiovascular disease, *n* (%)	53 (62.4%)
Musculoskeletal disease, *n* (%)	46 (54.1%)
Kidney/liver disease, *n* (%)	3 (3.5%)
Lung disease, *n* (%)	12 (14.1%)
Cancer, *n* (%)	8 (9.4%)
Parkinsons disease, *n* (%)	2 (2.4%)
Other, *n* (%)	16 (18.8%)

Table 2.

Descriptive statistics and bivariate correlation analyses

	M	*SD*	Skew	Kur	α	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Wear time (min/day)	722.79	68.71	0.46	-0.84		.30**	-.30**	-.21	-.24*	-.05	-.13	.00	.16	.05	.10	-.09	.05	.01	.07
2. SB (%)	70.52	11.01	-0.08	0.23			-1.0**	-.64**	-.50**	-.30**	-.22*	.20	.56**	-.20	.38**	-.39**	.28*	.37**	.51**
3. Light PA (%)	28.11	10.20	0.02	0.00				.55**	.47**	.27*	.19	-.17	-.53**	.20	-.37**	.39**	-.27*	-.37**	-.49**
4. MVPA (%)	1.37	1.37	1.52	3.91					.48**	.35**	.29**	-.36**	-.50**	.10	-.35**	.21*	-.18	-.28**	-.43**
5. PCS-12	41.34	11.76	-0.30	-1.13	0.84					.37**	.08	-.38**	-.59**	.19	-.70**	.57**	-.43**	-.54**	-.66**
6. FEV_1 (liter/m^2)	0.65	0.18	0.27	-0.07							.52**	-.06	-.49**	.27*	-.39**	.22*	-.35**	-.30**	-.37**
7. Grip (kg)	21.45	10.85	1.13	1.53								.11	-.34**	.02	-.07	.02	-.08	-.04	-.15
8. BMI (kg/m^2)	28.16	4.93	0.66	0.26									.12	.05	.20	-.07	.03	.09	.09
9. Mobility (seconds)	13.58	7.40	1.82	2.76										-.39**	.58**	-.47**	.36**	.52**	.59**
10. MCS-12	53.43	9.29	-1.40	2.20	0.80										-.38**	-.56**	-.46**	-.40**	-.63**
11. Vitality	4.23	1.40	-0.13	-0.39	0.92											-.50**	-.63**	-.69**	-.66**
12. Anxiety	4.82	3.50	0.54	-0.25	0.83												.65**	.55**	.60**
13. Depression	3.92	2.78	0.78	0.26	0.70													.65**	.70**
14. Fatigue	48.80	16.60	0.37	-0.07	0.57-0.82														.64**

15. QoL	21.78	6.34	0.61	-0.18	0.82

Note. *<.05, **<.01, Skew = Skewness, Kur= Kurtosis, α = Cronbach's alpha reliability coefficients, Light PA = Light physical activity, MVPA= Moderate-to-vigorous physical activity, PCS-12 = Physical health from SF-12, FEV_1 = Forced expiratory volume in 1 second, Grip = Grip strength, BMI = Body mass index, SB = Sedentary behavior, MCS-12 = Mental health from SF-12, QoL = Quality of life from the COOP Dartmouth chart, Descriptive statistics and bivariate correlation analyses were calculated after imputing missing data points.

Table 3.

Classes Identified via Latent Profile Analyses

Fit statistics	1 Class	2 Classes	3 Classes	4 Classes
AIC	1961.76	1648.78	1591.90	1550.80
BIC	2000.84	1729.38	1714.03	1714.46
SSA-BIC	1950.36	1625.28	1556.29	1503.09
Entropy	-	0.97	0.92	0.93
BLRT *p*-value	-	0.000	0.000	0.000
Percent of participants per class (%)	100	28.2, 71.8	27.1, 41.2, 31.8	29.4, 30.6, 27.1, 12.9

Note. AIC= Akaike information criterion, BIC= Bayesian information criterion, SSA-BIC= sample-size adjusted BIC, BLRT= Bootstrapped likelihood ratio test, Percent of participants per class (%)= the proportion of participants in each of the classes in the model.

Table 4.

Latent Profile Characteristics in the Three-Class Model (Unstandardized Scores)

	Class 1: (*n* ≈23; 27.1%)		Class 2: (*n* ≈35; 41.2%)		Class 3: (*n* ≈27; 31.8%)				
	M	*SD*	*M*	*SD*	*M*	*SD*	$d_{2\text{-}1}$	$d_{3\text{-}1}$	$d_{3\text{-}2}$
SB (%)	81. 50	9.61	71.63	8.56	59.01	7.31	-1.04	-2.60	-1.57
Light PA (%)	17.40	9.56	27.09	8.80	38.43	6.71	1.06	2.58	1.42
MVPA (%)	0.09	0.08	1.29	1.02	2.56	1.64	1.50	2.05	0.96
PCS-12	30.87	8.69	40.46	10.87	51.28	9.11	0.95	2.29	1.07
FEV_1	0.54	0.15	0.64	0.17	0.77	0.24	0.57	1.13	0.67
Grip	16.11	10.01	22.01	14.01	25.20	11.14	0.47	0.86	0.25
BMI	30.51	5.93	28.11	5.28	26.24	3.40	-0.43	-0.90	-0.41
Mobility	23.14	8.05	10.51	3.01	9.52	2.98	-2.27	-2.31	-0.33

Note. SB = Sedentary behavior, Light PA = Light physical activity, MVPA = Moderate-to-vigorous physical activity, PCS-12 = Physical health from SF-12, FEV_1 = Forced expiratory volume in 1 second, Grip = Grip strength, BMI = Body mass index, *d* = Cohen's *d* effect size statistic, Class 1: Low physical function and PA with a highly sedentary lifestyle, Class 2: Moderate physical function and PA with a moderate sedentary lifestyle, Class 3: High physical function and PA with an active lifestyle.

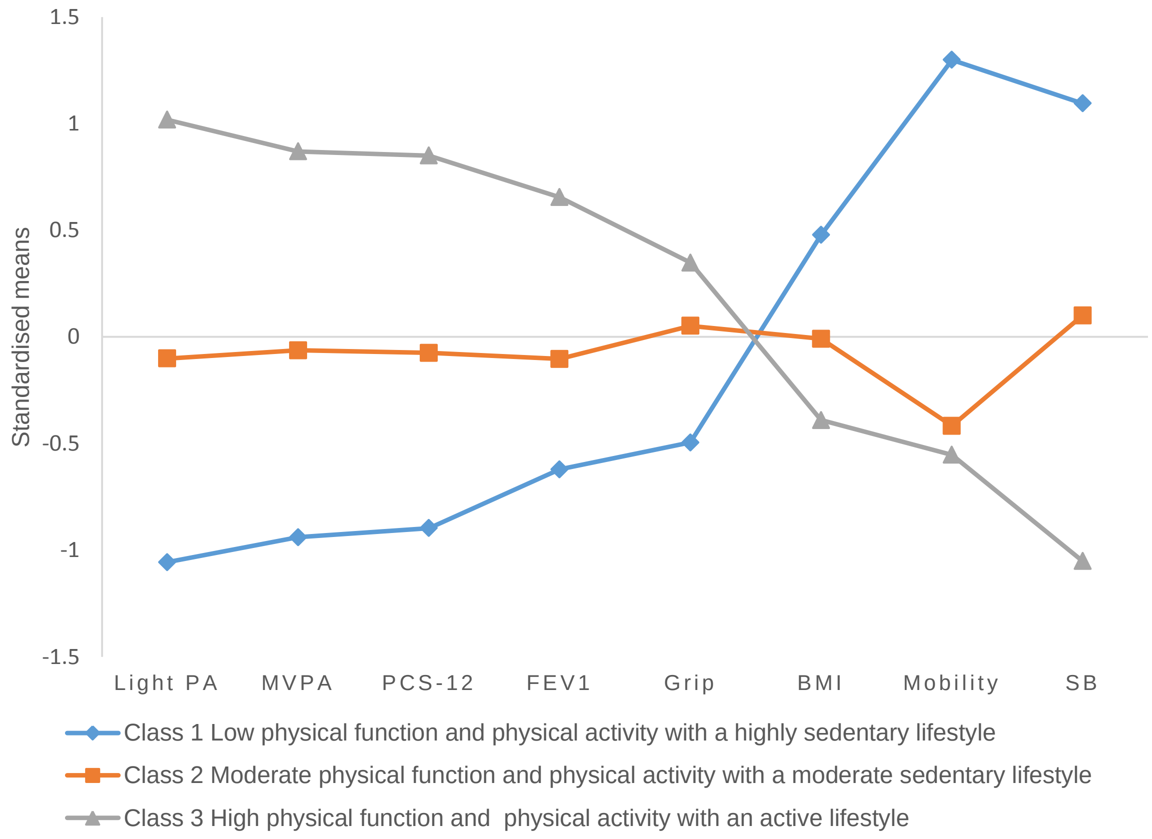
Table 5.

Description of the Three Latent Classes and χ^2 test for Differences Between the Classes in Mental Health

	MCS-12		Vitality		Anxiety		Depression		Fatigue		Quality of life	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Class 1	49.50	11.89	3.32	1.27	6.28	3.56	5.95	2.70	61.22	14.97	26.79	6.47
Class 2	54.42	8.40	4.36	1.47	5.20	3.72	3.93	2.75	50.68	14.75	20.92	5.59
Class 3	55.47	7.25	4.81	1.12	3.11	2.63	2.20	1.76	35.94	11.81	18.66	4.90
Class comparisons	χ^2	*p*	χ^2	*P*	χ^2	*p*	χ^2	*p*	χ^2	*p*	χ^2	*p*
Overall test	4.50	.108	19.40	.000	14.15	.001	34.08	.000	46.03	.000	24.58	.000
1 vs. 2	2.91	. 088	8.07	.004	1.20	.273	7. 49	.006	6.83	.009	12.48	.000
1 vs. 3	4.40	.036	19.07	.000	12.39	.000	32.61	.000	42.91	.000	24.42	.000
2 vs. 3	0.26	. 610	1.71	.191	6.26	.012	8.45	.004	17.94	.000	2.69	.101
Cohen`s *d* effect size												
$d_{2\text{-}1}$	0.50		0.80		-0.30		-0.74		-0.71		-1.00	
$d_{3\text{-}1}$	0.62		1.24		-1.02		-1.67		-1.89		-1.43	
$d_{3\text{-}2}$	0.59		0.33		-0.63		-0.73		-1.09		-1.39	

NOTE. Vitality = MCS-12= Mental health from SF-12, QoL = Quality of life from the COOP Dartmouth chart, Vitality = Subjective vitality, Class 1: Low physical function and physical activity with a highly sedentary lifestyle (*n* = 23) 27.1%, Class 2: Moderate physical function and physical activity with a moderate sedentary lifestyle (*n* = 35) 41.2%, Class 3: High physical function and physical activity with an active lifestyle (*n*= 27) 31.8%.

Fig. 1.



Mean scores of profiles for the three-class model (standardized scores)

Note. Light PA= Light physical activity, MVPA= Moderate-to-vigorous physical activity, PCS-12= Physical health from SF-12, FEV_1= Forced expiratory volume in 1 second, Grip= Grip strength, BMI= Body mass index, SB= Sedentary behavior